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CURRENT STATE AND OPPORTUNITY

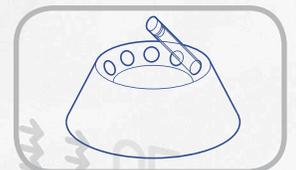
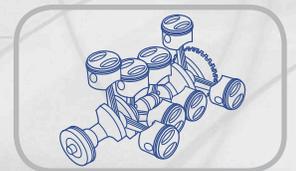
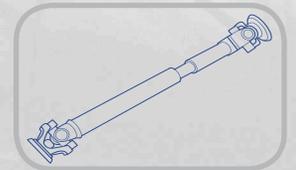
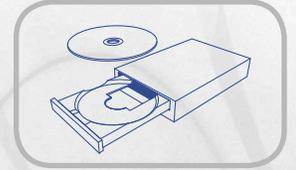
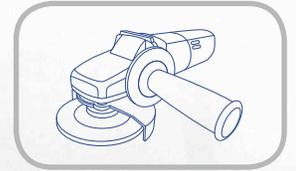
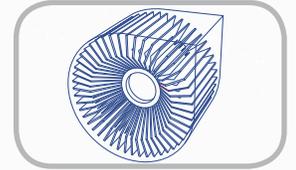
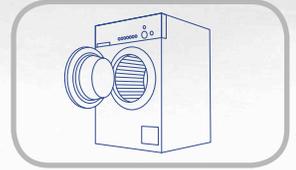
The XYO technology shows significant improvements in engine fan performance during independent studies. Perpetual Industries wants to work with innovative manufacturers to optimize and implement the XYO balancer in their product.

Contact us to see how your product can beat the competition using XYO



XYO PROTOTYPE BALANCER AS APPLIED TO ENGINE FANS Summary Report

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RESULT HIGHLIGHTS

The XYO technology reduces vibration by compensating for variable mass imbalance during the operation of industrial fans. Tests show that the a prototype XYO balancer had a significant impact on reducing vibration levels of these fans. Some of the benefits of using XYO include:

- ▶ Reduced manufacturing costs by eliminating conventional balancing
- ▶ Less mechanical wear and an increased product life
- ▶ Improved energy efficiency
- ▶ Quieter operation of fan

Engine Fan Vibration Decreased by 80%

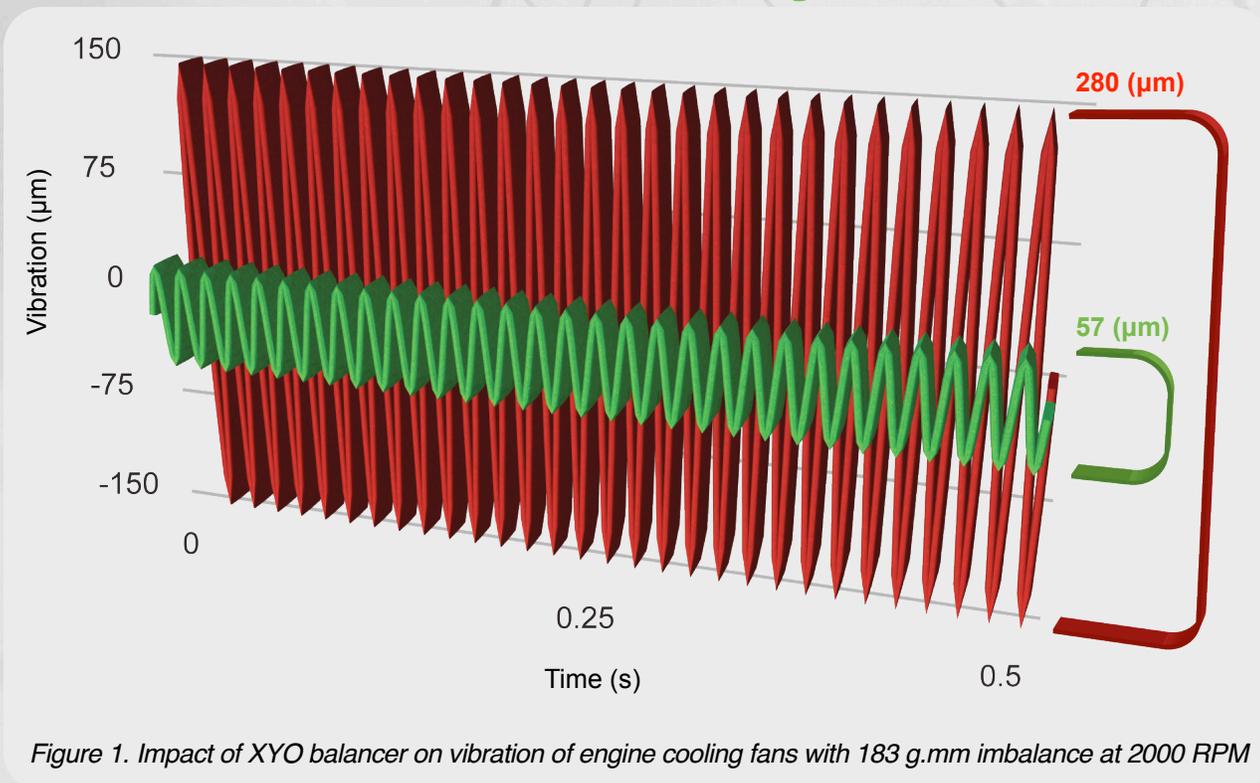


Figure 1. Impact of XYO balancer on vibration of engine cooling fans with 183 g.mm imbalance at 2000 RPM

■ WITHOUT XYO ■ WITH XYO

Note:

- ▶ The results in this report are based on a prototype XYO balancer design. While the results shown are significantly positive, it is possible to exceed and improve upon these results with optimization.
- ▶ Perpetual Industries is seeking a capable and innovative engine fan manufacturer to optimize and implement the XYO balancer in their product, and provide a competitive advantage.



INTRODUCTION

The primary cause of engine cooling fan vibration is mass imbalance due to manufacturing tolerances. Factory balancing is usually done after the fans come off the production line. This process is expensive, time consuming and does not account for balancing that may be required once the fan is in use. During normal operation, erosion and debris build-up can also contribute to the mass imbalance, leading to violent vibration.

TEST OBJECTIVE

The objective of the test was to determine the impact that an XYO system would have on the vibration of engine cooling fans (Figure 2).

TEST OVERVIEW

Vibrations were measured with two velocity probes on the shroud (Figure 3).

The prototype XYO balancer was designed with a compensating capacity of 180g.mm; however, **the XYO balancer capacity can be designed for larger imbalances if desired.** The XYO balancer was installed inside the hub of the impeller, as shown in Figure 4.

Four different mass imbalances were tested with and without an the XYO balancer installed on the engine fan:

- ▶ 0g.mm imposed imbalance
- ▶ 100g.mm imposed imbalance
- ▶ 183g.mm imposed imbalance
- ▶ 265g.mm imposed imbalance (over capacity)

A small screw and several nuts were used as imbalance masses and were positioned on the impeller as illustrated in Figure 5. The fan was allowed to run at an operating speed of 2000 RPM.



Figure 2. The front (right) and rear (left) of a sample engine cooling fan

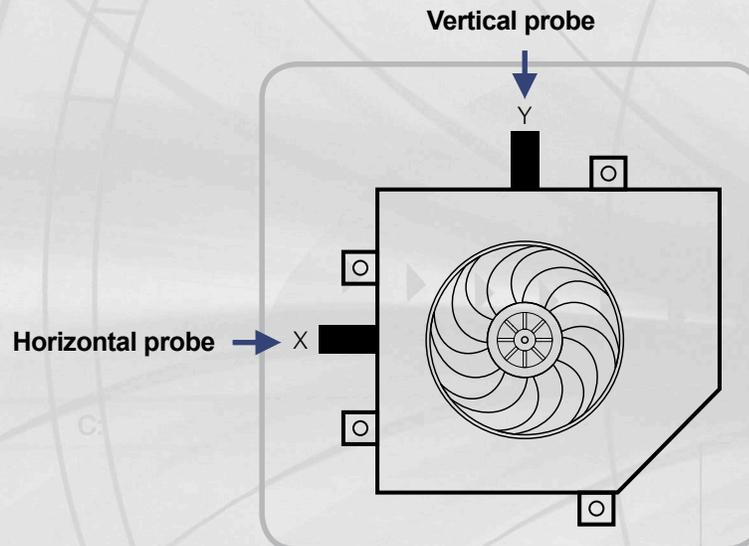


Figure 3. Location of vibration probes



Figure 4. Mounted XYO balancer

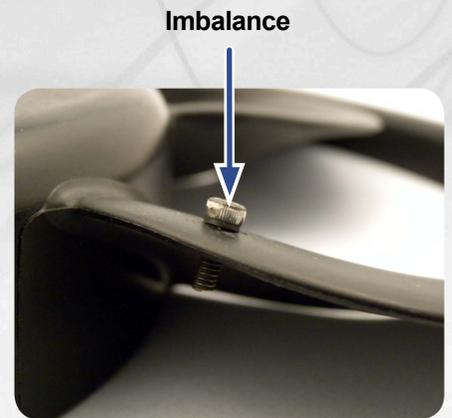


Figure 5. Imbalance on blade



TEST RESULTS

Figure 6 shows the results of different mass imbalances tested on an engine fan with an XYO balancer and an engine fan without an XYO balancer. The capacity of the XYO balancer tested in this study was 180g.mm, so when the 265g.mm mass imbalance was tested, the vibration measured with an XYO balancer increased slightly. Table 1 summarizes the results.

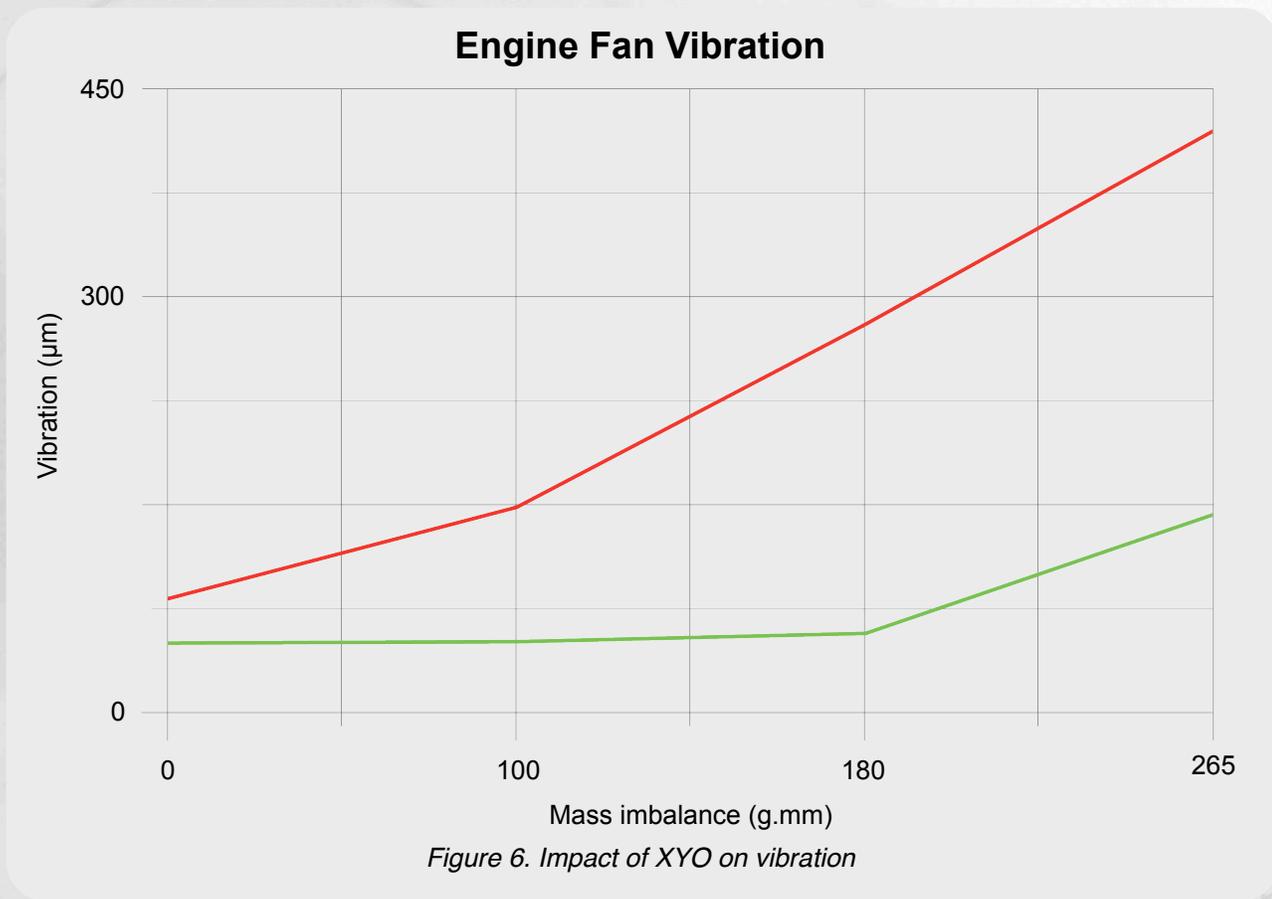


Figure 6. Impact of XYO on vibration

■ WITHOUT XYO ■ WITH XYO

Table 1. Summary of vibration results for engine fan

MASS IMBALANCE (g.mm)	VIBRATION (µm)		IMPROVEMENT (µm)
	WITHOUT XYO	WITH XYO	
0	82	50	32 (39%)
100	148	51	97 (66%)
183	280	57	223 (80%)
265	420	143	277 (66%)



FINDINGS AND CONCLUSIONS

The XYO technology was successfully applied to engine cooling fans. Vibration was significantly **(80%)** reduced using a prototype XYO balancer. Engine fan manufacturers can benefit with XYO in the following areas:

- ▶ Reduced manufacturing costs as factory balancing may no longer be necessary
- ▶ Reduced mechanical wear and maintenance increase the product's competitive advantage
- ▶ Quieter operation due to lower vibrations
- ▶ Increased energy efficiency

Perpetual Industries wants to work with capable and innovative manufacturers to optimize and implement the XYO technology and provide a strong competitive advantage in the market.

Impact of XYO:

- ▶ **Vibration reduced by 96%**
- ▶ **Lower manufacturing costs**
- ▶ **Quieter operation**
- ▶ **Decreased power consumption**
- ▶ **Increased product efficiency**

